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Evaluation of a 'zero-balance' inventory count concept for the Air Force standard base level supply system

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AN EVALUATION OF A 'ZERO-BALANCE' INVENTORY
COUNT CONCEPT FOR THE AIR FORCE STANDARD
BASE LEVEL SUPPLY SYSTEM

by

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Statement of Problem

For want of a nail, the shoe was lost
For want of a shoe, the horse was lost
For want of a horse, the rider was lost
For want of a rider, the battle was lost
For want of a battle, the kingdom was lost
And all for the want of a horseshoe nail.
--Margaret DeAngolis, Mother Goose.

Unfortunately, to this day the problem remains--if anything worse than before.

In the flow of materials from vendors, through warehousing, to issuing; confidence in inventory accuracy is critical. If the actual physical count of an item fails to conform to recorded inventory, problems will result. Since proper accounting is an important characteristic of inventories, the Air Force should use the most effective and economical approach to assure that inventory records agree with the quantity on hand.

The purpose of inventorying is to insure that posting and storage operations are accurate, thus insuring that stock record balances and quantities of stock on hand coincide. Inaccurate records may result in an unexpected inability to meet customer requirement, the purchase of unneeded stock, and an inaccurate cost of inventory. The Air Force currently uses a cyclic inventory checking scheme which spreads the complete inventory taking process over a year. Errors result since the system is indifferent to the quantity to be counted, and the rate of turnover for each item. Considering the continuing reductions in the defense budget, any change in a system which will reduce man-power requirements will aid in achieving the national goal of more viable and effective defense expenditures. The primary objective of this study is to evaluate a zero-balance count inventorying technique and empirically compare it to the current Air Force system.

The zero-balance inventory count concept takes into consideration the number of items on the perpetual inventory record; and selects an item for counting when the zero level is reached. This system has been installed at Sandia Laboratories, Albuquerque, New Mexico.[1] Results indicate both a reduction in off-cycle discrepancies and a reduction in man-hours to perform the count.

Organization of the Paper

The Air Force Standard Supply System is outlined in Chapter II to aid those not familiar with the internal workings, organizational structure, and objectives of the system. An analysis of current inventory schemes and the

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[1]Civier J. McGarr, "Zero-Count Inventory" Journal of Systems Management, Vol. 21 (February 1970), p. 38-39.

method now used by the Air Force is provided in Chapter III.

The zero-balance inventory count system is described and evaluated in Chapter IV by means of a feasibility study. Chapter V contains the summary and conclusion.

CHAPTER II

THE AIR FORCE STANDARD SUPPLY SYSTEM

Objectives

The Air Force Standard Supply system can be analogized to a wholesale organization which purchases its stock from several manufacturers and distributors. The system was designed around a UNIVAC 1050-II second-generation computer specifically designed to give the Air Force a real-time inventory system. By means of remote input/output units, transactions are processed as they occur. Item and financial records are updated concurrently. The objectives of the Standard Base Supply System are as follows:

1. An automated management system which, under program control, responds instantaneously and fully to all transactions as they occur.

2. A flexible capacity to support Air Force missions and other responsibilities designated by the Joint Chiefs of Staff and Department of Defense.

3. Compatibility of data links between electronic supply systems, Air Force, and Department of Defense transmission systems.

4. Reduced need for systems analysis and design by minimizing the number of supply system design agencies.

5. Greater discipline in enforcing supply policy.

6. More expedient, capable and efficient control in updating and modernizing automated supply equipment procedures and systems.

7. Development of standard training courses which enable supply personnel to perform effectively at automated bases in any command.

8. Standardized manning criteria for automated inventory control functions.

9. Standardized reporting of operational effectiveness data for management review at major command and HQ USAF Department of Defense level.

10. Standardized management data for all levels of management.

11. Accuracy and timeliness of management data for budget and buy programs.

12. Minimum use of external files.[2]

Maintaining an adequate inventory to support the needs of the assigned units is the underlying objective of the Supply System. The inventory is obtained from four basic sources: Air Force depots for Air Force peculiar items; Defense Supply Agency for Department of Defense items common to more than one service; General Services Administration for common "housekeeping" and office items; and Local Procurement for items not stocked by one of the above due to its peculiarity or low usage and being readily available from local commercial supplies.

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[2]The Air Force Supply Manual, AFM 67-1, Vol. II, Part Two, Feb. 1, 1971, p. 1-1.

Description

The normal cycle of an item record in the basic system is represented in Figure 1. An item record cycle is initiated when a customer request is input into the system. The input updates the item record; e.g., changes the balance on hand, the number of requests, date of last request, places a requirements computation indicator on the record and establishes detail records in certain instances. The requirements computation indicator is later used by the computer to determine which items need to be checked for reordering. If the reorder point has been reached or a stock-out condition exists, a reorder notice is printed.

The division of responsibilities in processing a customer's request is illustrated in Figure 2. After the issue document is printed, a warehouseman removes the proper item from its location for delivery to the customer. If the customer made a request when a stock-out condition existed, the property is handled by the receiving section upon receipt from the vendor. The receiving section is responsible for seeing that the correct item and quantity has been received. Inventory errors are most likely to occur during receiving and warehousing.

Management Control

The general guidance, all system design, and the operating budget come through staff channels to the individual Chiefs of Supply. The Chief of Supply function is a part of

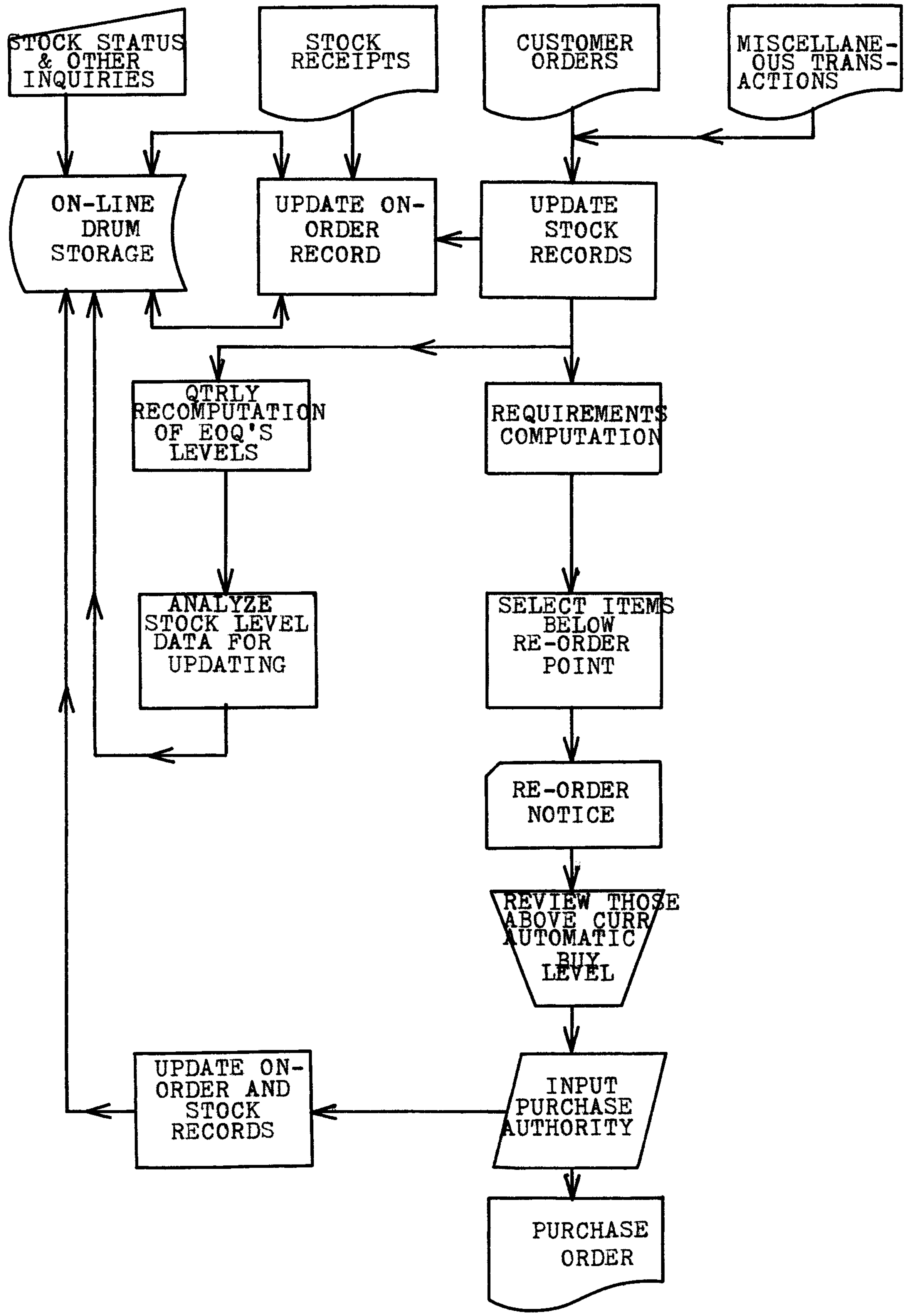

Figure 1.--Base Supply System Flowchart

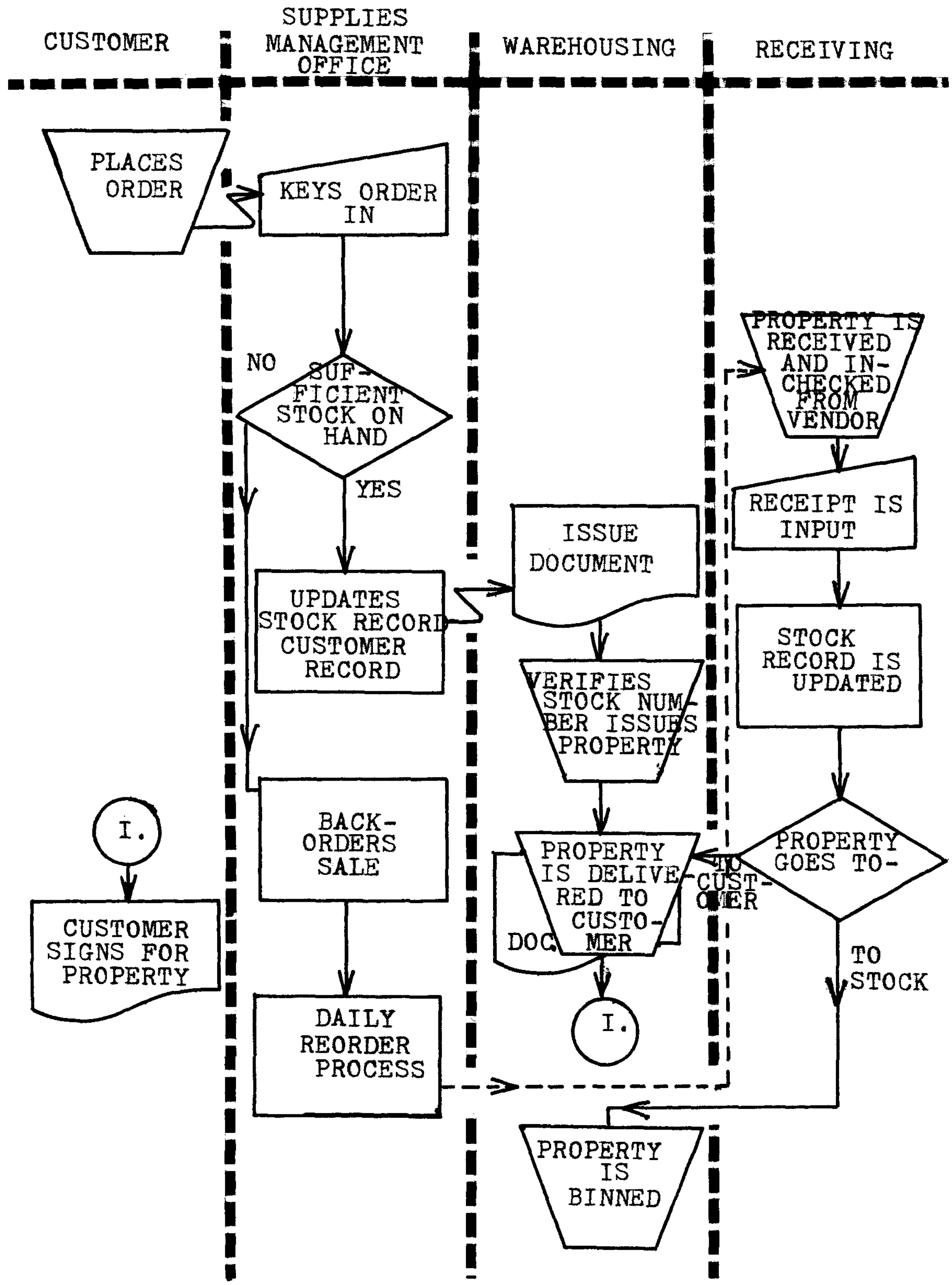

Figure 2.--Task-Oriented Flowchart

the group staff headed by the Base Commander. The Chief of Supply organizational chart comprises Appendix I.

The current trend is toward closer centralized monitoring and more controls being established by the Major Air Command staffs. This trend is the result of increasingly stringent budgets and improved capability for computer monitoring of the supply accounts.

The institution of manpower savings systems was stressed by Secretary of Defense Melvin R. Laird in his report to the House Armed Services Committee on March 9, 1971: "Of all the challenges facing the Department of Defense none is more important than modernizing manpower policies . . . Major reductions in military manpower--more than three quarters of a million men and women during the past three fiscal years--must be offset by improvements in the quality of our smaller forces."[3] Air Force Management is continually evaluating new ideas, systems, and programs for possible use within their framework so that decreases in the number of men in operating functions may be achieved.

Summary

The Air Force Standard Base Level Supply System has been outlined to aid those not familiar with the system. The internal workings of the system have been presented in two

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[3] "Manpower, Budget Show Reductions in Secretary Laird's Annual Report," Commanders' Digest, Department of Defense, March 20, 1971, pp. 1-2.

flowcharts. The necessity to investigate all possible management improvements was stressed in manpower and budget reports. In order to compare the proposed system, current inventorying schemes are described in the next chapter.

CHAPTER III

PHYSICAL INVENTORY SCHEMES

Philosophy and Methodology of Physical Inventory Counts

One key to improved inventory quantity control is accurate perpetual record balances. The perpetual records are expected to differ from the physical balance in some instances due to failures by employees to follow prescribed procedures.

Physical inventorying is a tool used to insure that these errors are caught and corrected. In conventional periodic or cyclic inventories, errors are not caught as they happen, but when they arise during the count. The true problems may remain hidden when management relies on conventional reconciling by physical counts. When discrepancies are found it is generally too late to even find out what happened, much less take really effective remedial steps.

Taking the inventory is like most other endeavors; the results depend mainly upon the effort put into preparation. The preparation for a physical inventory is normally divided into four steps.

1. Housekeeping. Making sure that all areas comply with good warehousing practices including proper arrangement of property, and cleanliness of bins and areas so that the property can be easily inventoried. This should be done daily,

not as an item requiring special attention prior to inventory. However, if it is not a daily procedure, it needs to be done prior to counting the inventory.

2. Identification. The quality of inventory depends on the accuracy of parts identification. In the Air Force, it is the basic responsibility of the inspection section in conjunction with the "receiving-in-checkers," to insure that every part being "in-checked" is identified and updated on the perpetual records in the computer.

3. Instruction. Unlike the two previous steps, this is a step to be taken just prior to counting the inventory. It involves letting everyone know what to do, what will be inventoried and the controls over normal activity while the inventory is in progress. In a sampling inventory process this step will have to be continually observed and enforced when selected items are identified for inventory.

4. Training. It is a basic requirement that people not only know their own job, but understand the total system and how their actions influence the objective of the inventory. This is especially true of those involved in maintaining accurate physical and perpetual inventory records.

In taking the inventory (all types) three separate actions are normally involved:

1. Count the property and record the count (normally on a punch card, however, a portable tape recorder is becoming popular in taking complete inventories of retail activities).

2. Verify the count by recounting or sampling. This can also be accomplished through programming the computer to reject the count card if the balance on the perpetual record disagrees with the physical count by more than X units or Y dollars. The Air Force has programmed its system to reject any count that disagrees with the recorded dollar-value by more than $25.00. If disagreement occurs the count is redone to verify its accuracy.

3. Adjust the inventory records for differences between record and actual physical quantities. An audit of large discrepancies is normally required.

Inventorying Classes

Periodic Inventories

The annual physical inventory, traditionally made during the first weeks in January, was done to obtain the amount of inventory on hand for tax purposes and exemplifies the periodic inventory. It usually involves closing the store or shutting down the production lines. The manpower and paperwork involved in this type of action often becomes very expensive. Since it is usually done under pressure, there is a push to complete the inventory and it is frequently done poorly. Under any conditions, using large numbers of people not well trained in the job of taking inventory almost always results in waste and errors. Not the least of the disadvantages of an annual physical inventory is that it results in correcting errors only once a year for most of the items. Because of these disadvantages and the maintenance of inventory records on computers, many companies have turned to some type of cyclic inventory method.[4]

Cyclic Inventories

Cycle inventory counting involves inventorying specific items at some prescribed interval throughout the year, so that the perpetual records can be verified regularly. Cyclic inventory avoids costly shutdowns and overtime premiums that normally result from the pressure to complete a total inventorying in a short time. Personnel can be trained as inventory specialists and employed the year around. Additionally, it spreads the counting of the inventory incrementally over longer periods of time.

There are disadvantages to cycle counting. The problem of establishing paperwork cut-off dates is difficult enough for a periodic inventory, but it becomes extremely challenging for cycle counts, made while normal activity is in progress. Considerable discipline is required to monitor the paperwork in the system so that the inventory can be properly reconciled.[5]

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[4] G. W. Plossl and O. W. Wright, Production and Inventory Control, Principles and Techniques, (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1967), p. 401.

[5] Ibid.

Current Air Force Procedure

Air Force procedures direct that every item be inventoried on a yearly cycle or when any error is detected.[6] The inventorying of items off-cycle is called a "special" inventory. Several methods of detecting errors are included in issuing procedures:

1. The issue document indicates when the last item is issued from the perpetual record. If the warehouseman notes that property is still on hand a discrepancy is reported. Researching the inventory records of the past year, indicated that an average of nine errors are reported per month.

2. A warehouse refusal occurs when an issue request is made and no property is available in the warehouse for issue. The past year's records report an average occurance of sixteen per month.

3. When the computer is unable to process transactions in line, "post-post" issues are made to fill customer requests. These "post-post" issues are input upon resumption of normal processing. Review of the inventory records the past year reflected an average of thirty-one "post-post" errors per month because the perpetual record was less than the actual quantity issued.

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[6] The Air Force Supply Manual, p. 12-13.

The current cyclic Air Force inventory system as symbolized in Figure 3 first scans for all item records within the warehouse space selected by the Inventory Section. A freeze code is placed on the item record selected to prevent any transactions from taking place that effect the balance. Next, the selected items are output in warehouse sequence and as count cards. The inventory is then counted and the quantity found is keypunched into the cards for input. A new date of inventory is assigned to the item record, and the freeze code is removed. The counts within a $25.00 latitude of the recorded balance are accepted. Discrepancies occuring within the $25.00 range automatically adjust the recorded balance. Those rejected because the count is not within the $25.00 range are audited if a difference remains after a recount.

In a 24,000 line item account it takes approximately 6,750 man-hours per year to count cyclical inventories and 2,250 man-hours on special inventories.[7]

Summary

Inventorying is a tool to correct man caused processing errors. Inventorying procedures are generally divided into two classes, periodic and cyclic. The cyclic method now used by the Air Force at Malmstrom consumes approximately

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[7]Mr. Robert J. Brunner, Inventorying Supervisor, private interview held at Malmstrom AFB, Montana, March 1971.

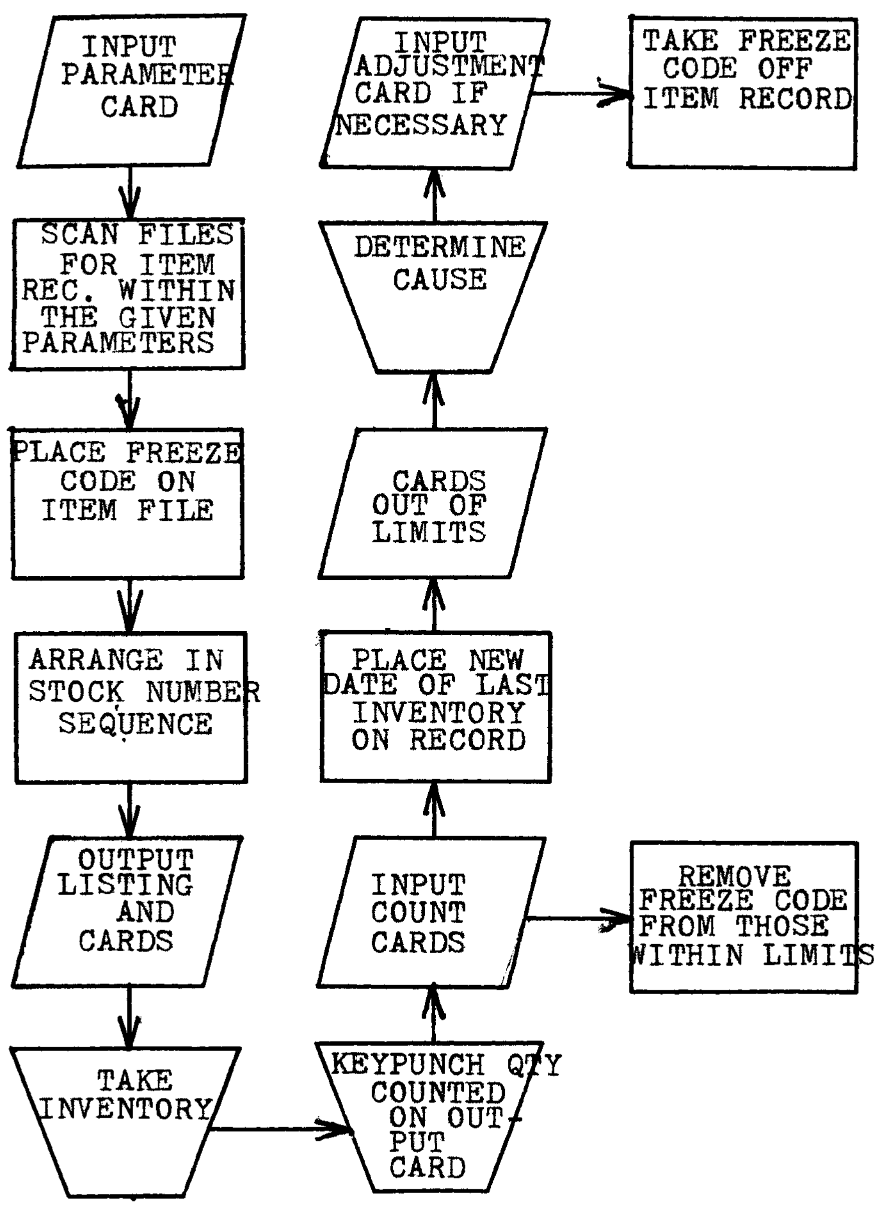

Figure 3.--Flowchart of Current Inventory Procedures

6,750 man-hours per year. The zero-balance inventory count system presented in the next chapter is designed to reduce the cost of inventorying.

CHAPTER IV

THE ZERO-BALANCE INVENTORY

Its Purpose and Basic Design

The zero balance count system is a type of cyclic counting based on the concept that active items are more prone to errors and that accurate counting during physical inventory is a prime problem. Therefore, the best time to take inventory is after some type of activity and when the item record balance is zero.[8] Counting inventory when balance is low highlights problems for correction as they occur and lowers the man-hours used for counting. Additional items are identified by record discrepancies detected during issue processing.

The system is designed to select all item records having a zero balance within the warehouse locations designated by the Inventory Section. The proposed system is represented in Figure 4 and is very similar to the current system depicted in Figure 3. The input parameter card will allow for a more varied selection of the items to be inventoried; e.g., the recorded balance (0, 1, 2, 3, . . ., n), date of last inventory taking count, date of last request

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[8]McGarr, "Zero-Count Inventory," p. 38.

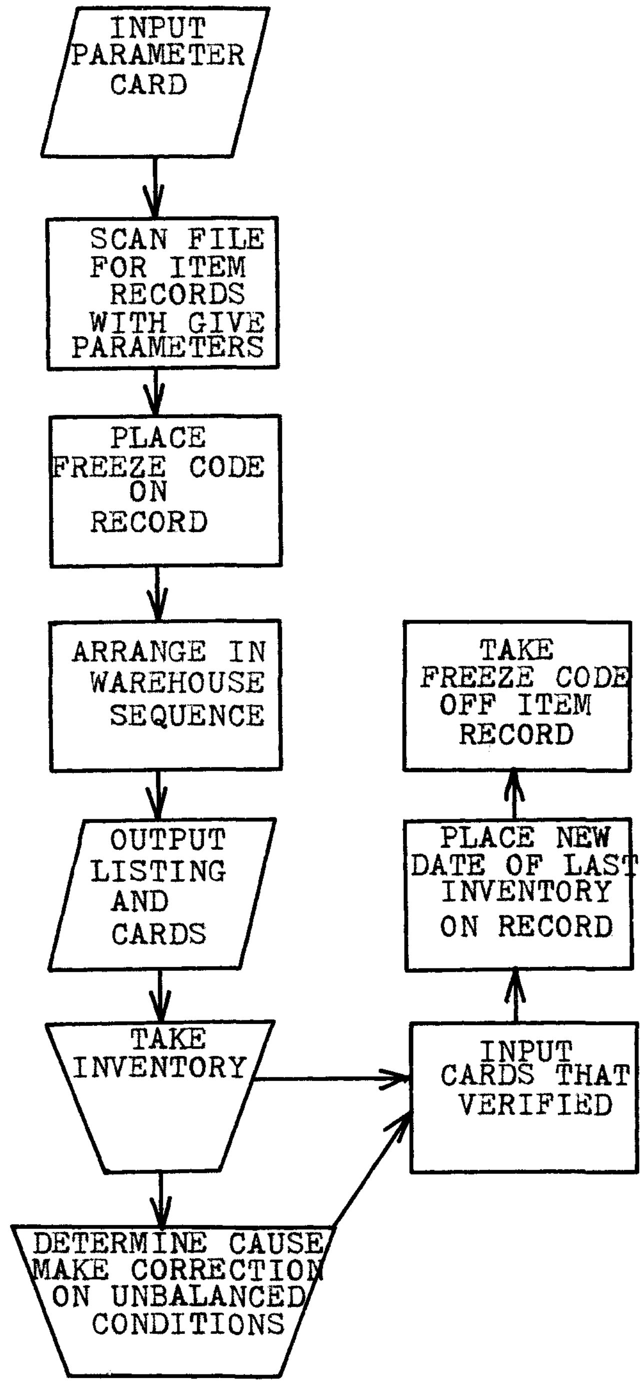

Figure 4.--Flowchart of "Zero-Balance" Count Inventory Procedures

and by the desired warehouse locations. As items are selected, a freeze code is placed on the item record. Next, cards and a listing are printed for the taking of the inventory. Those with a balance on hand will be held for auditing; the others processed. Inputing the cards will remove the freeze code and update the date of last inventory filed on the item record.

The selection of zero-balances is a method of attaining a sample of the inventory to determine if the number of items on hand and the perpetual records are in agreement. Statistical sampling has been accepted for determining the validity of perpetual records by the American Institute of Certified Public Accountants.

> Since samples taken for this purpose (to test compliance with inventory control) are intended to provide a basis for relying on compliance with internal control procedures, The AICPA believes they should be evaluated at a reliability level the auditor considers reasonable in light of factors other than the procedures themselves.................[9]

The benefits which are expected to be attained through the implementation of the zero-balance count procedures are:

1. Better utilization of the inventory specialist's time.

2. Better control of all stock on hand.

3. Abandonment of the 100 percent physical inventorying requirement.

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[9] "Relationship of Statistical Sampling to Generally Accepted Auditing Standards" a special report by the committee on statistical sampling of the American Institute of Certified Public Accountants, <u>Journal of Accountancy</u>, Vol. 118 (July 1964), p. 57-58.

The Air Force's Economic Order Quantity formula stresses the unit cost of an item.[10] This results in lower stock levels for items with high unit costs, all other variables being equal. The effect of unit cost changes on three different levels of demands are illustrated by the three curves in Figure 5. The three curves on the graph represent the computed demand level for a fixed number of demands at varying unit costs. For example, the demand level for items experiencing 50 demands during a year will range from 35 items when the cost is one dollar to eleven items when the unit cost exceeds $40.00. The curves indicate the demand level decreases as the unit price increases. Therefore, a stock-out condition is more likely to occur for higher priced items and the sampling of the inventory will be biased toward the items with a higher unit price.

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[10]Economic Order Quantity = $\frac{4.4\sqrt{DDR*VSO*UP}}{UP}$

DDR = Daily Demand Rate
VSO = Variable Stockage Objective in Days
UP = Unit Price

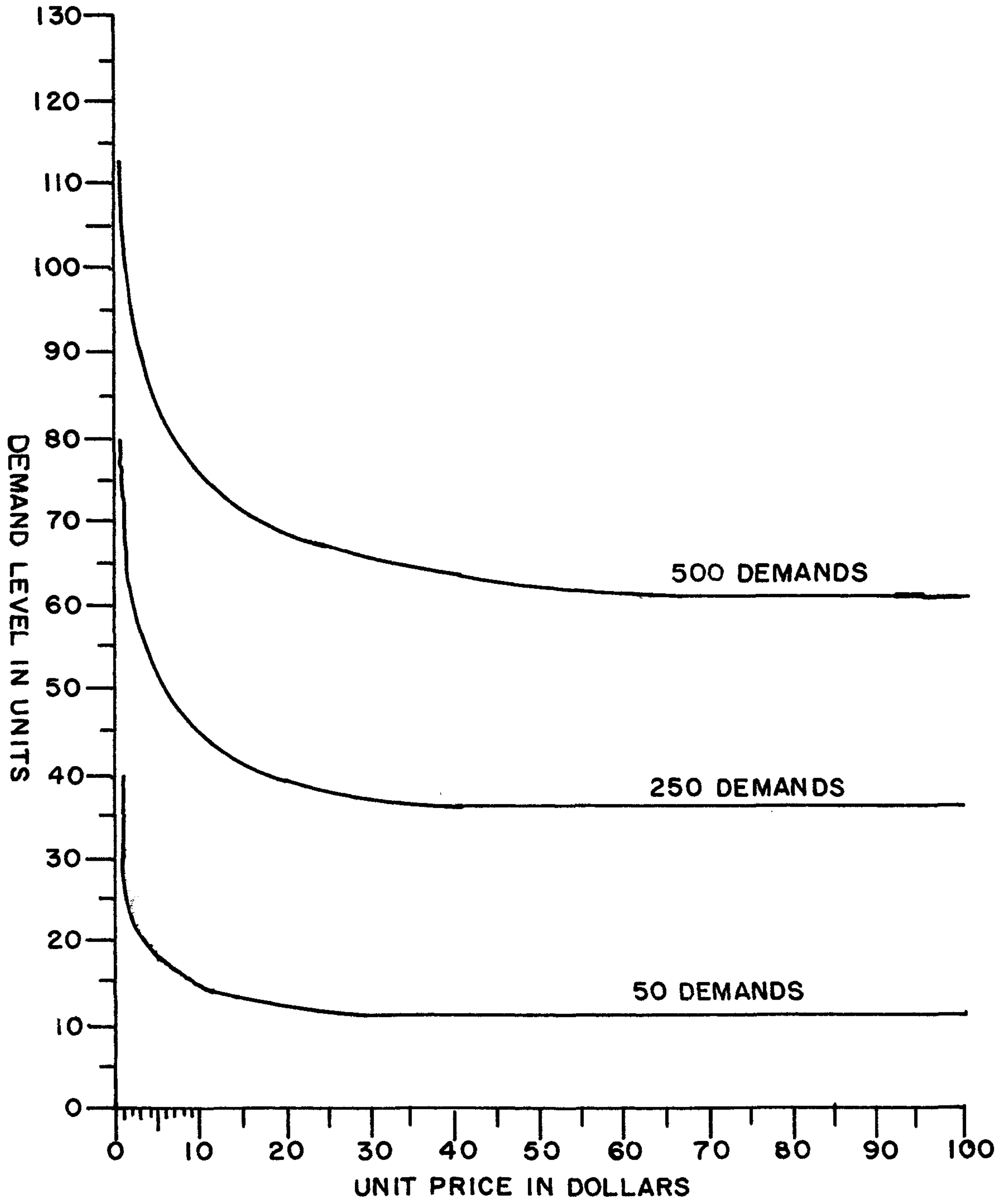

Figure 5.--Effects of Unit Price Change
On Demand Level

The Feasibility Study

The Objectives

The objective of conducting the feasibility study is to test the following hypotheses:

1. That the zero-count system will reduce manpower requirements.
2. It will be a valid sample of the inventory.
3. The inaccuracies of counting will be removed.

The results of a zero-balance inventory system will be obtained through: 1) collecting data, 2) verifying the data, and 3) comparing the two systems.

Collecting Data

The first steps in determining the validity of the results of a zero-balance sample was to observe current inventory procedures, test the counting accuracy, and then make comparative zero-balance counts. All differences were audited to insure transactions between the time the program was run and the time the inventorying was made had not created the out-of-balance condition.

Next a procedure to verify the samples reliability was adapted from a method derived by William H. Kraft[11] from the Baysian Decision process (combining prior management judgment with test data). A model is presented in Tables 1 and 2 by

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[11]William H. Kraft, Jr., "Statistical Sampling for Auditors: A New Look," *Journal of Accountancy*, Vol. 126 (August 1968), p. 44-56.

which the inventory supervisor or others assure themselves the sample properly represents the population (all property on hand). Tables 1 and 2 are explained immediately below.

In order to use the tables a base must first provide quantitative assurance of the accuracy of current inventory. A cumulative method is the best way. The cumulative probabilities that an error rate in a sample of one hundred would happen are shown in Table 1, column 2. Based on past experience, Malmstrom's management is 95 percent sure that the actual error rate will be less than 5 percent. This level of assurance was taken from past data on inventory accuracy rates. The current method of indicating the accuracy of the inventory found during the cyclic and special inventorying is to divide the total unit adjustments by the total units counted and subtract from one hundred to arrive at an accuracy percentage rate. The validity of this figure is subject to conjecture as a certain amount of pressure is asserted to keep the inventory accuracy rate high. The probabilities of individual error rates shown in Table 1, column 3 were derived by successively subtracting the cumulative probabilities in column 2. The error rates for the samples in this example stops at 10 percent. It could have been carried out further if current assurance of inventory reliability had been less.

Next the conditional probabilities resulting from the sample are computed. The conditional probabilities were computed by determining the probability of finding three errors if the actual error rate of the system is 5 percent. The

TABLE 1

METHOD BY WHICH PROBABILITIES FOR TABLE 2 ARE COMPUTED

Possible Error Rates (1)	Cumulative Subjective Probability of Error Rate (2)	Original Subjective Probability of Error Rate (3)	Probability of: 5 or Less Errors (4)	Probability of: 6 or Less Errors (5)	Probability of: 6 Errors (6)	Joint Probability Column (3) Times Column (6) (7)	Revised Final Probability (8)	Final Cumulative Probabilities (9)
.01	.25	.25	.999	1.000	.001	....	....	....
.02	.50	.25	.983	.995	.012	.003	.067	.067
.03	.75	.25	.916	.966	.050	.013	.289	.356
.04	.90	.15	.785	.889	.104	.016	.356	.712
.05	.95	.05	.616	.762	.146	.007	.156	.868
.06	.96	.01	.446	.606	.160	.002	.044	.912
.07	.97	.01	.301	.450	.149	.001	.022	.934
.08	.98	.01	.191	.313	.122	.001	.022	.956
.09	.99	.01	.116	.207	.091	.001	.022	.978
.10	1.00	.01	.067	.130	.063	.001	.022	1.000
		1.00						

TABLE 2

CUMULATIVE PROBABILITIES OF ERROR FOR A SAMPLE OF 100

Possible Error Rates	Cumulative Subjective Probability	Revised Final Cumulative Probabilities For a Sample of 100 and n Errors							
		n=0	n=1	n=2	n=3	n=4	n=5	n=6	n=7
.01	.25	.648	.438	.235	.097	.036	.014	.000	.000
.02	.50	.887	.761	.582	.389	.245	.139	.067	.038
.03	.75	.979	.937	.868	.753	.627	.486	.356	.270
.04	.90	1.000	.989	.980	.941	.891	.805	.712	.617
.05	.95	1.000	1.000	1.000	.986	.973	.930	.868	.810
.06	.96	1.000	1.000	1.000	.993	.982	.958	.912	.848
.07	.97	1.000	1.000	1.000	1.000	.991	.972	.934	.886
.08	.98	1.000	1.000	1.000	1.000	1.000	.986	.956	.924
.09	.99	1.000	1.000	1.000	1.000	1.000	1.000	.978	.962
.10	1.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

source of the sample probabilities is a cumulative Poisson Distribution table. The probability of a given number of errors was found by taking the difference between N errors and N-1 errors to find the probability of N errors. For example, the probability of five or fewer errors given an error rate of 5 percent is .616, and the probability of six or fewer errors is .762. The probability of six errors is the difference between .762 and .616 or .146. The entries under the Sample Probability Columns (Table One) were derived in this manner.

Two measures of probability are presented. One based on management's judgments and the other based on actual sample results, both are jointly combined in a final cumulative probability.

First, the two probabilities (original subjective probability of the error rate and the conditional probability of the actual sample) are multiplied to derive a joint probability. The individual entries are then divided by the total of the joint probabilities. The resulting individual quotient is the individual revised probability of the error rates. The revised probabilities are summed in order to arrive at the final cumulative probability.[12]

The final probabilities for samples of one hundred

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[12] This process is an application of Bayes Therom. See George J. Brabb, Introduction to Quantitative Management (New York: Holt, Rinehart & Winston, Inc., 1968) p. 115.

and N errors are presented in Table 2. Reference to Table 2 indicates that if five or fewer errors are found, management's prior expectations of a 5 percent error rate is 93 percent assured.

If management had not added its subjective probability, finding six or fewer errors in a sample of one hundred items would give only a thirty-eight percent confidence factor that the 5 percent error-rate hypothesis was true.

This method will assist the Base Supply Managers in determining the adequacy of the sample by presetting a reliability goal (90 percent) at an error rate consistent with the area being inventoried. Assume the expected error rate of a nuts and bolts sample is 5 percent, then reading across Table 2, at the 5 percent error rate, one finds that the reliability of that sample would be above 90 percent until the sixth error was found. In a sample of one hundred it would then drop to 87 percent, which might or might not be acceptable depending upon current circumstances.

Obviously, Table 2 covers only a few of the possible sample sizes and subjective probabilities to given error rates. Other tables could be built; in fact, a set of tables for Air Force use could be developed easily by a computer program with error rates and probabilities added by local management. However, exactness is not necessary before probabilities can help management:

> The theory of probability does not replace judgment and experience. Its utility lies rather in the fact that it allows us to make more effective use of our judgment and experience by assigning probabilities to those events on which our experience and judgment bear most directly.[13]

Zero-Balance Method Compared to Current Air Force Method

A comparison of the current Air Force method and the zero-balance method is presented in Table 3. Analysis of columns 4 and 5 show that a 100 percent inventory count can do more harm to the inventory accuracy than the resulting adjustments correct. The number of man-hours required to conduct the inventorying of the area under current procedures is contained in column 7. The corresponding zero-count inventorying sample of the area inventoried is shown in columns 8 through 12. Column 11 indicates the zero-balance samples were over the 90 percent confidence level for the expected error rate of 5 percent. The man-hours expended in conducting the zero-balance inventorying is shown in the last column. The man-hours expended in counting the total inventory was 25 times that of the zero-balance method.

Limitation

Counting only items with a recorded zero-balance does have a limitation. Only overages will be found in the zero-

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[13]Robert Schlaifer, Introduction to Statistics for Business Decisions, (New York: McGraw Hill, 1961), p. 192, Quoted in William H. Kraft, Jr., "Statistical Sampling for Auditors: A New Look," Journal of Accountancy, Vol. 126 (August 1968), p. 56.

TABLE 3

AUDITED RESULTS OF THREE CYCLE INVENTORIES AND ZERO-COUNT INVENTORIES

One Hundred Percent Physical Inventory

Area Invntor'd (1)	Units on Record (2)	Line Items (3)	Count Errors Units (Dollars) (4)	Inventory Adjustments Units (5)	Inventory Adjustments Dollars (6)	Man-hours to Count (7)
04B	11,291	346	502[b]	122	201.63	9
			(+ 30.82)	(+96)	(+125.36)	
			(-163.47)	(-39)	(- 76.27)	
06A	22,254	523	737[c]	73	38.81	16
Row 14			(+534.97)	(+34)	(+ 18.54)	
Thru 22			(-192.95)	(-39)	(- 20.27)	
06A						
Row 23						
Thru 26	13,007	307	276[d]	161	79.90	12
			(+120.45)	(+84)	(+ 24.05)	
			(- 28.82)	(-77)	(- 55.85)	

[a]When the sample contained less than the 100 items with a zero balance, a simple linear function was drawn to extend the sample to 100 and the errors extended proportionately.

[b]Only 112 units would have been accepted as automatic adjustments at the current Air Force edit limit of $25.00.

[c]Only 446 units would have by-passed the $25 edit limit for automatic adjustments.

[d]Two hundred and thirty-two units would have by-passed the $25 edit limit for automatic adjustments.

TABLE 3--Continued

Zero-Balance Inventory Count

Units Recorded (8)	Line Items in Sample (9)	Line Items Adjusted (10)	Sample Reliability (11)	Inventory Adjustments Units (12)	Inventory Adjustments Dollar (13)	Man-hours to Count (14)
0	73	4	.93	+16	+10.35	.50
0	103	3	.98	+26	+19.54	.66
0	76	2	.98	+13	+ 8.72	.33

balance cyclic counting process. Consequently, the detecting of shortages is limited to finding errors during issue procedures described in Chapter III. Two possible safeguards are offered here:

1. The first method would be to select (every month) the item records that have not gone to zero, thus have not been checked during the past two years. A special inventorying could be conducted on the items selected.

2. The second method is to make a quick observation of active warehouse locations within the zero-balance sample space for other emply locations. Any found should be audited for possible shortages.

Neither method is time consuming enough to negate the manpower savings in switching to a zero-balance count sample.

Inventory Errors

A survey of the unbalanced conditions between the item records and physical balances for the past year indicate a number of causes. A tabulation of the audited errors for the nine months of fiscal year 1971 as a percentage of total errors follows:

1. Issues processed prior to completed receipt/turn-in actions. 5%

These were normally caused by items being removed from the receiving/turn-in lines for issue before or while receiving/turn-in documents were being processed.

2. Duplicate posted receipts and turn-ins. 11%

These occur when improper suspensing, interruptions in paper flow, or lost paperwork cause a second set of documents to be entered in the computer.

3. Receiving errors. 8%

These are caused by the "in-checker" entering the quantity requested but not shipped and not noting an overage or shortage on the receiving document.

4. Property found out of proper location. 13%

These occur when a warehouseman places an item in the wrong bin row or shelf, or moves an item for cleaning and fails to replace it.

5. "Post-post" errors. 49%

These occur at a time when the "real-time" error routine is lost due to the computer being down for maintenance, reports, or environmental problems. Although only 3 or 4 percent of the issues are made when the computer is down, "post-post" errors account for almost 50 percent of the inventory errors. The loss of property might not be caught for some time if documents are totally lost and physical movement of the property has taken place.

6. "Reverse-post" transactions. 4%

At times it is necessary to cancel out certain transactions. These are called "reverse-post" transactions. "Reverse-post" transactions can become a very tedious procedure if many transactions are linked to the one being reversed. If the transactions are not input in the proper sequence, an unbalanced condition might result.

7. Miscellaneous 11%

Errors in this category were caused by using the wrong stock number, loaning items, or incorrectly identifying property.

Eighty-three percent of the errors involved a computer input. Further analysis of audit trails found these item records at a zero-balance condition within 45 days of a computer input 70 percent of the time. A summary of the February and March 1971 inventories and the total accumulated inventory adjustments for the first nine months of fiscal year 1971 are shown in Appendix II.

Dollar Benefits

The expected dollar benefits of instituting the zero-balance count system are computed as follows:

1. Current man-power for inventorying Malmstrom's 24,000 line-item account require a supervisor and five counters. The annual salary for the six employees is $32,781. The number of employees could be reduced to two; thereby saving $18,256 per year at current salary rates. The savings would be at least equalled at the other 129 Air Force Bases. Ninety percent of the other Air Force Supply accounts are larger and have more personnel assigned.[14]

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[14] *The Air Force Supply Manual*, Vol. I.

2. Savings estimated to be $5,000 annually are expected by reducing purchases of items understated on the perpetual inventory records. Appendix II shows that during the first nine months of fiscal year 1971, the inventory was increased by $4,000 through inventory adjustments.

Conversion

Implementation could take place at a pre-set date. The pretested program changes could be loaded the night before, and operation under the zero-balance method could start the next day. Conversion may be planned to coincide with the start of a new fiscal year or with normal end-of-month processing to facilitate reporting changes that will occur.

Summary

The zero-balance inventory count was described and evaluated in this chapter. A "confidence table" utilizing an adaptation of Bayes' Theorem provides management with the capability of judging the reliability of the zero-balance sample. A summary and conclusion are presented in Chapter V.

CHAPTER V

SUMMARY AND CONCLUSION

The purpose of this study was to evaluate the effectiveness of a proposed zero-balance inventory count method. The zero-count method was suggested as a replacement for the current cyclic inventorying procedures used in Air Force Standard Base Supply Systems.

The zero-balance inventory count procedure is a statistical sampling technique which indicates that the perpetual inventory record is fairly stated in relation to the physical inventory. The current system was tested against zero-count method using the same data. This provided a statistical comparison of the two methods. A limitation of selecting only items with a zero-balance was discussed and two methods presented to offset the sample's bias. The results of this study indicate that utilization of the zero-count inventory method will result in:

1. A 96 percent savings in the man-hours required to complete an inventory.
2. The reduction of erroneous purchases by identifying items when the perpetual record reaches zero.
3. The virtual elimination of counting errors that distort the inventory value.

The zero-balance inventory count method, serves as a management indicator emphasizing those aspects of the inventory

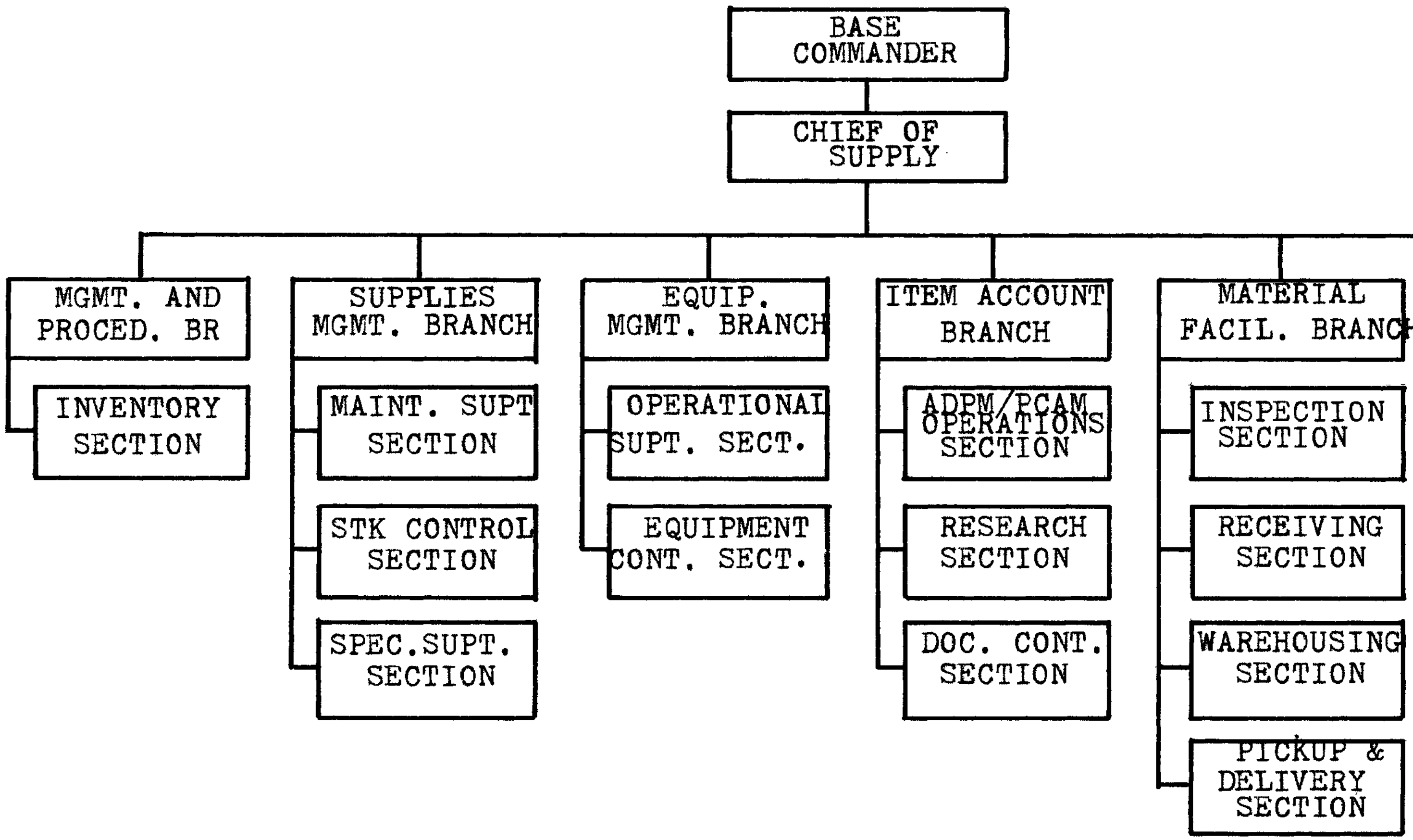
APPENDIX II

Recorded Economic Order Quantity Inventory Performance Malmstrom AFB, Montana

July 1970 - March 1971

	Line Items			Recorded Balance	
Period	Counted	Over	Short	Units	Dollar Value
March Cycle Inventory	241	11	9	17,943	22,322
March Special Inventory	21	4	17	622	938
February Cycle Inventory	781	30	35	31,011	64,952
February Special Inventory	21	13	8	114	323
Total Special And Cycle July 70 Through March 71	9,830	482	653	382,651	564,604

APPENDIX



Appendix I

Chief of Supply Organizational Chart

APPENDIX II--Continued

Over		Short		
Units	Dollar Value	Units	Dollar Value	Accuracy
194	223	50	48	98.6%
12	208	557	406	8.6%
218	534	102	256	99.0%
35	1,250	192	93	0.0%
7,872	3.964	8,018	3,661	95.8%

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